

What is claimed is:

1. A filter, comprising:

a tubular member;

a shaft extending through the tubular member;

5 an expansion frame mounted on the distal end of the shaft, the frame expandable between a contracted condition and an expanded condition, the frame comprising a flexible ring;

a flexible cantilever beam that slideably extends from a distal end of the shaft and bisects the frame, and contacts the frame at a distal end of the cantilever; and

10 a filter mesh attached to the expansion frame.

2. The filter of claim 1, wherein the flexible cantilever beam includes a flexible hinge.

3. The filter of claim 1, wherein the flexible cantilever beam includes  
15 a flexible spring.

4. The filter of claim 1, wherein the flexible cantilever beam comprises a wire having a weakened region.

5. The filter of claim 1, wherein the flexible cantilever beam comprises a nitinol tube of generally cylindrical shape.

6. The filter of claim 1, wherein the cantilever is constructed from a composite of materials.

7. The filter of claim 6, wherein the cantilever is constructed of bare wire, plastic tube, and metal outer sheath.

5 8. A medical device for filtering embolic material, comprising:  
a cannula having a proximal end, a distal end, and a lumen therebetween,  
the lumen communicating with a port at the distal end;

a port on an outer surface of the cannula and located adjacent a distal  
region of the cannula, the port having a passage extending distally and communicating  
10 with a distal opening in the port;

a filter removably insertable through the passage of the port, the filter  
comprising a flexible tubular member, a flexible shaft extending through the tubular  
member, and an expansion frame mounted on the distal end of the shaft, the frame  
expandable between a contracted condition and an expanded condition, the frame  
15 deployable through the distal opening of the passage of the port, a distal end of the shaft  
insertable through the passage of the port while a proximal end of the shaft extends  
outside the port; and

a filter mesh attached to the expansion frame.

20 9. The device of claim 8, wherein the filter cartridge provides a  
hemostatic seal between the expandable filter and the port.

10. The device of claim 8, wherein the expansion frame comprises a plurality of struts.

11. The device of claim 8, wherein the cannula further includes a suture flange.

5 12. The device of claim 8, wherein the distal region of the cannula is at approximately a 90 ° angle relative to the proximal region.

13. The device of claim 8, wherein the proximal end of the cannula is adapted for attachment to a bypass-oxygenator.

10 14. The device of claim 8, wherein the distal opening of the port is separate from the lumen of the cannula and the distal port on the cannula, and extends into a lumen of a vessel during use.

15. The device of claim 14, wherein the filter further comprises a flexible cantilever beam that slideably extends from a distal end of the shaft and bisects the expansion frame, and is bonded to the frame at a distal end of the cantilever.

15 16. The device of claim 8, wherein the distal opening of the port merges and communicates with the lumen of the cannula proximal to the distal port on the cannula.

17. The device of claim 16, wherein the filter is inserted through the passage of the port, through the lumen of the cannula, and into the vessel distal to the distal port on the cannula.

18. A method for filtering blood, comprising the steps of:  
5 providing a tubular member, a shaft extending through the tubular member, an expansion frame mounted on the distal end of the shaft, a flexible cantilever beam that slideably extends from a distal end of the shaft and bisects the frame, and is bonded to the frame at a distal end of the cantilever, and a filter mesh attached to the expansion frame;

10 inserting a cannula into a vessel;  
inserting the tubular member into a port on the cannula;  
advancing the filter into the vessel;  
deploying the filter within the vessel; and  
removing the filter from the vessel, wherein embolic material is captured  
15 by the filter.

19. The method of claim 18, wherein the filter cartridge provides a hemostatic seal between the expandable filter and the port.

20. The method of claim 18, further comprising the additional step of  
20 removing the filter from the port.

21. A method for filtering blood, comprising the steps of:  
providing a cannula having a proximal end, a distal end, a lumen  
therebetween, and a port at the distal end, located adjacent a distal region of the cannula,  
providing a filter cartridge removably insertable through the passage of the  
5 port, the filter cartridge comprising a flexible tubular member, a flexible shaft extending  
through the tubular member, and an expansion frame mounted on the distal end of the  
shaft, and a filter mesh attached to the expansion frame;  
inserting the cannula into a vessel;  
inserting the filter into the port on the cannula;  
10 advancing the filter through the passage into the vessel;  
deploying the filter within the vessel; and  
removing the filter from the vessel, wherein embolic material is captured  
by the filter.

15 22. The method of claim 21, wherein the filter cartridge provides a  
hemostatic seal between the expandable filter and the port.

23. The method of claim 21, further comprising the step of removing  
the filter from the port.

24. A medical device, comprising:

a cannula having a proximal end, a distal end, and a lumen therebetween,  
the lumen communicating with a port at the distal end; and

a port on an outer surface of the cannula and located adjacent a distal  
5 region of the cannula, the port having a passage extending distally and communicating  
with a distal opening in the port, wherein at least a portion of the passage extends  
alongside the cannula,

wherein the cannula lumen is circular and the passage is crescent-shaped  
in a cross-section taken through the portion of the passage that extends alongside the  
10 cannula.

25. The medical device of claim 24, further comprising a filter for  
filtering embolic material extending through the passage in the port.

26. The medical device of claim 24, wherein the lumen of the cannula  
is an arterial return lumen.

27. A filter, comprising:

a tubular member; and

an expansion frame mounted on the distal end of an elongate member that slideably extends through the tubular member, the frame expandable between a contracted condition and an expanded condition, the frame comprising a cantilever beam that slideably extends from a distal end of the tubular member and bisects the frame, and a flexible ring that is bonded at one end to an end of the cantilever beam, circles twice around the circumference of the frame, and is bonded at another end to the end of the cantilever beam.

28. The filter of claim 27, further comprising a filter mesh attached to the expansion frame.

29. A filter, comprising:

a tubular member; and

an expansion frame mounted on the distal end of an elongate member that slideably extends through the tubular member, the frame expandable between a contracted condition and an expanded condition, the frame comprising a flexible ring that is pivotally bonded to the elongate member.

30. The filter of claim 29, further comprising a filter mesh attached to the expansion frame.

31. A filter, comprising:

a tubular member; and

an expansion frame mounted on the distal end of an elongate member that  
slideably extends through the tubular member, the frame expandable between a

5 contracted condition and an expanded condition, the frame comprising a flexible ring that  
is bonded to the elongate member, the flexible ring being formed of a thicker and stiffer  
material near its point of attachment to the elongate member and a thinner and more  
flexible material farthest from its point of attachment to the elongate member.

10 32. The filter of claim 31, further comprising a filter mesh attached to  
the expansion frame.